

Contents

Frontispiece A.....	i
Frontispiece B.....	iii
Executive Summary	v
Glossary and Acronyms.....	xiii
Contents	xix
1.0 Introduction.....	1
1.1 Storage Study	1
1.1.1 Authorization and Purpose.....	1
1.1.2 State of Washington Participation	2
1.1.3 Process	2
1.2 Black Rock Alternative Assessment.....	2
1.3 Assessment Summary Report	3
2.0 Black Rock Alternative.....	5
2.1 Defining the Alternative	5
2.2 Water Exchange Concept.....	6
3.0 Yakima-Columbia River Water Exchange	7
3.1 Amount of Potential Water Exchange	7
3.1.1 Potential Water Exchange Participants.....	7
3.1.2 Existing Water Delivery Systems of Potential Water Exchange Participants	8
3.1.2.1 Upstream From MP 22.6 - Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts	13
3.1.2.2 Downstream From MP 22.6 - Roza Irrigation District and Sunnyside Division.....	15
3.1.3 Potential Exchange Participants' Water Rights	15
3.2 Columbia River Water Exchange Supply	19
3.2.1 Seasonal Instream Flow Targets	19
3.2.2 Water Supply in Excess of Seasonal Instream Flow Targets	21
3.2.3 Water Delivery Criteria for Potential Exchange Participants	23
3.2.4 Storage and Pumping Plant Capacities	24
4.0 Water Rights and Water Service Contracts	27
4.1 Introduction.....	27
4.2 Current Status.....	28
4.2.1 Participating Irrigation Entities.....	28
4.2.2 Water Service Contracts	28
4.3 Water Appropriation From the Columbia River.....	29
4.3.1 Background.....	29

CONTENTS

4.3.2 Columbia River Initiative	29
4.3.3 Diversion Authorization Approaches	29
4.3.3.1 Application Under State Water Code	29
4.3.3.2 Columbia Basin Project Withdrawal and Transfer	30
4.3.3.3 In-Lieu Exchange.....	31
4.3.3.4 Modify Existing Rights.....	31
4.3.4 Comparison of Approaches.....	32
4.3.5 December 2004 Notice of Withdrawal Made	32
4.4 Water Rights	33
4.4.1 Relinquishment	33
4.4.2 Priority Date.....	34
4.4.3 Source/Point of Diversion.....	34
4.5 Water Service Contracts	35
5.0 Black Rock Alternative Facilities	37
5.1 Options Considered.....	37
5.2 Level of Detail	42
5.3 Site Characteristics.....	43
5.3.1 Topography	43
5.3.2 Geology.....	43
5.3.2.1 Regional Geology	43
5.3.2.2 Geology of Columbia River Intake and Inflow Conveyance Areas	44
5.3.2.3 Geology of Black Rock Damsite	44
5.3.2.4 Geology Along Outflow Conveyance System and at Black Rock Powerplant and Delivery System Areas.....	51
5.3.3 Groundwater	51
5.3.3.1 Capability of Reservoir Basin to Retain Stored Water	53
5.3.3.2 Movement of Groundwater.....	53
5.3.4 Seismotectonics.....	54
5.3.5 Probable Maximum Flood	55
5.4 Columbia River Intake Facilities	56
5.4.1 Intake, Trashracks, and Fish Screens.....	56
5.4.1.1 3,500-cfs Pump Only Option	56
5.4.1.2 6,000-cfs Pump Only Option	57
5.4.1.3 3,500-cfs Pump/Generation Option	57
5.4.2 Pumping Plant and Switchyard.....	57
5.4.2.1 3,500-cfs Pump Only Option	58
5.4.2.2 6,000-cfs Pump Only Option	58
5.4.3 3,500-cfs Pump/Generation Plant and Switchyard	58
5.5 Inflow Conveyance System	59
5.5.1 3,500-cfs Pump Only Option	59
5.5.1.1 All Tunnel Inflow Conveyance.....	59
5.5.1.2 Tunnel/Pipeline Inflow Conveyance.....	60
5.5.2 6,000-cfs Pump Only Option	60
5.5.3 3,500-cfs Pump/Generation Option	61

CONTENTS

5.6 Black Rock Storage Facilities.....	61
5.6.1 Storage Dam Alignment	61
5.6.2 High Seismicity.....	62
5.6.3 Potential Fault Displacements.....	62
5.6.4 Large Rockfill Embankment Dam	63
5.6.4.1 Foundation Treatment.....	63
5.6.4.2 Large Concrete Face Rockfill Dam	64
5.6.4.3 Large Central Core Rockfill Dam.....	64
5.6.5 Large Roller Compacted Concrete Dam.....	65
5.6.6 Small Rockfill Embankment Dam	66
5.6.7 Small Roller Compacted Concrete Dam.....	66
5.6.8 Spillway	66
5.6.9 Low-Level Outlet Works	66
5.6.10 Reservoir.....	67
5.6.11 Highway and Utility Relocations.....	67
5.7 Black Rock Reservoir Outflow.....	68
5.7.1 Conveyance System	68
5.7.2 Outlet Facility	73
5.7.3 Outlet Powerplants.....	75
5.7.3.1 Black Rock Powerplant and Switchyard.....	75
5.7.3.2 Sunnyside Powerplant and Related Facilities.....	76
5.8 Appraisal-Level Water Delivery System Plans	77
5.8.1 Plans For Delivery Upstream From MP 22.6	78
5.8.1.1 Upstream Plan 1 – 215-cfs Exchange Using High-Pressure Pipeline.....	80
5.8.1.2 Upstream Plan 2 – 175-cfs Exchange Using High-Pressure Pipeline.....	81
5.8.1.3 Upstream Plan 3 – 175-cfs Exchange Using Low-Pressure Pipeline	82
5.8.1.4 Upstream Plan 4 – 325-cfs Exchange Considering Three Pipeline Options .	83
5.8.1.5 Upstream Plan 5 – 325-cfs Exchange Delivery With Checks and Relift Pumps.....	85
5.8.1.6 Upstream Plan 6 – 35-cfs Exchange	86
5.8.2 Plans for Delivery Downstream From MP 22.6 – Roza and Sunnyside Divisions	87
5.8.2.1 Downstream Plan 1 – Pipeline From Black Rock Outlet Facility	87
5.8.2.2 Downstream Plan 2 – Modified Roza Canal and New Pipeline	88
5.8.3 Preliminary Reactions to Appraisal-Level Delivery Plans	88
5.8.3.1 Roza Division Input	88
5.8.3.2 Sunnyside Division Input.....	89
5.8.3.3 Selah-Moxee Irrigation District Input.....	90
5.8.3.4 Union Gap Irrigation District Input	90
5.8.4 Delivery System Conclusions	91
5.8.4.1 Upstream From MP 22.6.....	91
5.8.4.2 Downstream From MP 22.6.....	91
6.0 Black Rock Reservoir Operation	93
6.1 Operations Concept.....	93
6.2 Reservoir Capacity.....	94
6.3 Operational Analysis.....	94

CONTENTS

6.3.1 Time Required for Initial Reservoir Filling	94
6.3.2 Annual Pumping	94
6.4 Reservoir Contents.....	97
6.5 Potential Reservoir Surface Area.....	99
7.0 Field Construction Cost Estimates.....	101
7.1 Black Rock Assessment Field Data	101
7.2 Comparison of Major Facilities	102
7.3 Comparison of Alternative Configurations.....	105
7.4 Summary of Field Construction Cost Estimates.....	107
7.5 Total Project Costs.....	108
8.0 Black Rock Alternative Effects	109
8.1 Effects of Exchange Water in the Yakima River Basin.....	109
8.1.1 Instream Flows.....	109
8.1.1.1 Introduction.....	109
8.1.1.2 Methodology	109
8.1.1.3 Easton Reach.....	113
8.1.1.4 Cle Elum Reach	114
8.1.1.5 Wapato Reach	116
8.1.1.6 Naches Reach.....	117
8.1.2 Irrigation	119
8.1.3 Municipal Water Supply	120
8.2 Diversion of Columbia River Water.....	121
8.2.1 Instream Flows.....	121
8.2.2 Hydrologic Models	121
8.2.3 Yakima River Inflow Changes.....	121
8.3 Hydropower Generation and Pumping Energy.....	126
8.3.1 Existing Facilities.....	126
8.3.2 Pumping Energy Requirements and Costs.....	130
8.3.3 Effects on Current Hydropower Generation	131
8.3.3.1 Non-Federal Hydropower Projects	131
8.3.3.2 Federal Hydropower Projects	132
8.3.3.3 Combined Regional	133
8.3.4 Black Rock Alternative Hydropower Generation.....	134
8.3.4.1 Intake Pump/Generation	134
8.3.4.2 Generation at Points of Water Discharge.....	135
8.3.4.3 Transmission Facilities	136
8.3.5 Columbia River Treaty and Operating Agreement Impacts	136
8.4 Columbia River Fish and Wildlife Issues	137
8.4.1 Existing Fishery Resources.....	137
8.4.1.1 Anadromous Fish.....	137
8.4.1.2 Resident Fish.....	138

CONTENTS

8.4.2 Wildlife and Habitat Resources	139
8.4.3 Fish and Wildlife Issues and Data Needs	139
8.5 Cultural Resources	141
8.5.1 Cultural Context.....	141
8.5.2 Managing Cultural and Historic Resources	142
8.6 Recreation	143
9.0 Further Black Rock Alternative Investigation Needs	145
9.1 Technical Viability of the Black Rock Alternative.....	145
9.1.1 Exchange Water.....	145
9.1.2 Water Supply	146
9.1.3 Pump/Generation	146
9.1.4 Storage Dam.....	147
9.1.5 Reservoir.....	147
9.1.6 Irrigation Delivery Systems	148
9.1.7 Cultural Resources	148
9.1.8 Fish and Wildlife Resources	149
9.1.9 Cost Estimates.....	149
9.1.10 Economic Justification and Financial Viability	149
9.2 Conclusions.....	150
10.0 References.....	151

Appendices

Appendix A – Reclamation’s December 28, 2004, letter requesting a Columbia River water withdrawal

Appendix B – Washington Infrastructure Services, Inc.’s review comments on Reclamation’s *Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Final Report, Technical Series No. TS-YSS-2*

Tables

Table ES-1. Summary of major facilities for three preliminary Black Rock alternative configurations	ix
Table 3-1. Current water rights of potential water exchange participants	15
Table 3-2. Reduced Yakima River water diversion resulting from a water exchange and the amounts of Yakima River water that would be available for other uses	17
Table 3-3. Allocation of freed-up Yakima River exchange water	18
Table 3-4. Seasonal flow targets and planning dates for the main stem Columbia River	21
Table 3-5. Average monthly water available for pumping in the vicinity of Priest Rapids Dam in excess of instream flow targets	22

CONTENTS

Table 3-6. Columbia River water supply needs based on water rights of Roza and Sunnyside Divisions	23
Table 3-7. Direct delivery water supply based on 810,400-acre-foot April - October water rights	24
Table 4-1. Approaches for acquiring State authorization to divert Columbia River water	32
Table 5-1. Summary of major facilities for three preliminary Black Rock alternative configurations	41
Table 5-2. Summary of test drilling WIS performed at original Black Rock damsite	46
Table 5-3. Summary of test drilling Reclamation performed at alternate Black Rock damsite ..	46
Table 5-4. Probable maximum floods for a Black Rock reservoir	55
Table 5-5. Preliminary Priest Rapids 3,500-cfs pumping plant unit data	58
Table 5-6. Preliminary Priest Rapids 3,500-cfs turbine unit data	59
Table 5-7. Comparison of large and small rockfill embankment dams	66
Table 5-8. Comparison of large and small RCC dams	66
Table 5-9. Preliminary Black Rock reservoir parameters	67
Table 5-10. Preliminary Black Rock powerplant unit data	75
Table 5-11. Preliminary Sunnyside powerplant unit data	76
Table 5-12. Preliminary irrigation requirements based on six appraisal-level water delivery plans	77
Table 5-13. Water delivery by mainline delivery system to lands upslope of Roza Canal	79
Table 5-14. Upstream delivery plan 6 Yakima River diversion requirements	86
Table 6-1. Monthly water volumes that could be pumped from Priest Rapids Lake for a 1,300,000-acre-foot active capacity reservoir and a 3,500-cfs pumping capacity	95
Table 6-2. Monthly water volumes that could be pumped from Priest Rapids Lake for an 800,000-acre-foot active capacity reservoir and a 6,000-cfs pumping capacity	96
Table 6-3. End-of-month reservoir contents based on meeting the water delivery criteria	97
Table 6-4. Dry-year carryover based on a 1,300,000-acre-foot active capacity reservoir and 3,500-cfs pumping capacity	98

CONTENTS

Table 6-5. Dry-year carryover based on an 800,000-acre-foot active capacity reservoir and 6,000-cfs pumping capacity	99
Table 6-6. Summertime reservoir pool based on end-of-month reservoir contents and a 157,610-acre-foot inactive pool	100
Table 7-1. Comparison of appraisal-level construction pay item cost estimates for potential major facility options	104
Table 7-2. Comparison of appraisal-level field construction costs for three preliminary configurations of the Black Rock alternative.....	106
Table 7-3. Appraisal-level field construction cost estimates of select delivery system plans...	107
Table 8-1. Cle Elum reach comparison of smolt out migration flows.....	115
Table 8-2. Proratable water users.....	119
Table 8-3. Current and projected municipal demands	120
Table 8-4. Yakima River basin water supply conditions (1981-2003).....	122
Table 8-5. Average monthly Yakima River flows at Kiona gauge based on wet, average, and dry Yakima River basin water supply conditions	125
Table 8-6. Summary of hydroelectric projects in the mid-Columbia River system	129
Table 8-7. Preliminary monthly pumping energy requirements to pump to a Black Rock reservoir	130
Table 8-8. Preliminary monthly change in non-Federal Columbia River hydropower generation related to operation of the Black Rock alternative.....	132
Table 8-9. Preliminary monthly change in Federal Columbia River hydropower generation related to operation of the Black Rock alternative.....	133
Table 8-10. Preliminary monthly change in regional combined non-Federal and Federal hydropower generation related to operation of the Black Rock alternative	133
Table 8-11. Preliminary new powerplants at points of water discharge.....	135

Figures

Frontispiece A. Yakima River Basin Water Storage Feasibility Study overview map	i
Frontispiece B. Overview of the preliminary Black Rock alternative configurations.....	iii

CONTENTS

Figure 3-1. Schematic of potential water exchange participants' existing irrigation systems, diversion points (in parenthesis), and connection to the Black Rock alternative	10
Figure 3-2. Irrigated lands of potential water exchange participants.....	11
Figure 3-3. Peak Roza Canal flows and facilities upstream from MP 22.6.....	14
Figure 5-1. Schematic of the Black Rock alternative facility options	39
Figure 5-2. Locations of the two Black Rock damsites and exploratory drill holes.....	45
Figure 5-3. Generalized geologic section through the alternate Black Rock damsite	47
Figure 5-4. Stratigraphic section of geologic units in drill hole DH-04-1	49
Figure 5-5. Preliminary Black Rock reservoir outflow conveyance system	71
Figure 5-6. Preliminary Black Rock outlet facility flow diagram – canal delivery option	73
Figure 5-7. Preliminary Black Rock outlet facility flow diagram – pipeline delivery option	74
Figure 5-8. Flow diagram of upstream delivery plan 1	80
Figure 5-9. Flow diagram of upstream delivery plan 2	81
Figure 5-10. Flow diagram of upstream delivery plan 3	82
Figure 5-11. Flow diagram of upstream delivery plan 4	84
Figure 5-12. Flow diagram of upstream delivery plan 5	85
Figure 5-13. Flow diagram of upstream delivery plan 6	86
Figure 8-1. The four identified stream reaches and related Reclamation gauge locations	112
Figure 8-2. Comparison of estimated median monthly Easton reach flows under the three scenarios (based on the 1981-2003 period of record)	113
Figure 8-3. Comparison of estimated median monthly Cle Elum reach flows under the three scenarios (based on the 1981-2003 period of record)	114
Figure 8-4. Comparison of estimated median monthly Wapato reach flows under the three scenarios (based on the 1981-2003 period of record)	116
Figure 8-5. Comparison of estimated median monthly Naches reach flows under the three scenarios (based on the 1981-2003 period of record)	117
Figure 8-6. Average monthly flows at Kiona gauge under wet water supply conditions.....	123
Figure 8-7. Average monthly flows at Kiona gauge under average water supply conditions....	124

CONTENTS

Figure 8-8. Average monthly flows at Kiona gauge under dry water supply conditions	124
Figure 8-9. Mid-Columbia River hydroelectric system.....	128

CONTENTS